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AUTHOR Tamir, Pinchas
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ABSTRACT

The study compares the achievement of Jewish and Arab students in the high school biology matriculation examinations in Israel with special reference to differences between boys and girls. While Jewish and Arab students follow the same syllabus and take identical matriculation examinations, significant differences exist in learning and achievement patterns. Major differences reported include: (1) girl:boy ratio of Jewish biology majors is 3:1 compared with 1:1 for the Arab biology majors; (2) Arab and Jewish girls achieve generally as well as boys; (3) Jewish students achieve better especially on tasks which require higher cognitive abilities; (4) Arab student have, on the average, more difficulty in handling multiple choice items; (5) the differences between Jewish and Arab students in paper and pencil tests are substantially larger than those obtained in practical laboratory tests; and (6) the gap between Jewish and Arab students appears to be closing especially in tasks which require either lower cognitive abilities or simple process laboratory skills. Possible reasons for the differences found and trends identified are discussed. (Author/ML)

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ACHIEVEMENT OF JEWISH AND ARAB STUDENTS WHO STUDIED INQUIRY ORIENTED CURRICULUM FOR SEVERAL YEARS

Pinchas Tamir

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School of Education and Israeli Science Teaching Center
Hebrew University Jerusalem

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Abstract

The study compares the achievement of Jewish and Arab students in the high school biology matriculation examinations in Israel with special reference to differences between boys and girls. While Jewish and Arab students follow the same syllabus and take identical matriculation examinations, significant differences exist in learning and achievement patterns. For example:

* The girls:boys ratio of Jewish biology majors is 3:1 compared with 1:1 in the Arab biology majors.
* Arab and Jewish girls achieve generally as well as boys. However in the lower level exams Arab boys achieve better than girls.
* Jewish students achieve better especially on tasks which require higher cognitive abilities.
* Arab students have, on the average more difficulty in handling multiple choice items.
* The differences between Jewish and Arab students in paper and pencil tests are substantially larger than those obtained in practical laboratory tests.
* The gap between Jewish and Arab students appears to be closing especially in tasks which require either lower cognitive abilities or simple process laboratory skills.

Possible reasons for the differences found and trends identified are discussed.

INTRODUCTION

Israel is the Jewish State, but not all its citizens are Jewish. In 1984 there was about three and a half million Jews and over 600,000 Arabs living in Israel.

In the year 1947, before the State of Israel was founded, only 30% of the Arab children had attended elementary schools, very few attended high school and there were virtually no Arabs in higher education. This state of affairs was in sharp contradiction with that found in the Jewish community which had succeeded to develop a high level autonomous educational system during the British Mandate. For the Jewish population eight years of schooling was the norm in 1947 and the percentage of children attending high schools as well as institutions of higher education was comparable to that of most developed Western countries.

Dramatic changes have occurred during the last four decades and today most Arab students complete at least nine years of schooling, many continue in high schools and the number of Arabs in institutions of higher education has been steadily increasing. While in 1948 there was only one Arab high school, today fifty-six Arab high schools are operating all over the country. The change in educational opportunities has been most dramatic for girls: while in the early 1950's very few girls attended high school, in 1984 47% of the Arab students in high schools are girls (Saad, 1984).

By and large Jewish students study in Jewish schools while Arab students study in Arab schools. This is so mainly due to the wish of each of the two nations to study in their own native language, namely Hebrew and Arabic respectively. However, the formal curriculum in many of the main school subjects (those which are relatively culturally independent such as mathematics, English and the sciences) has been the same for all students regardless of their nationality. As a result of their late start Arab high schools had suffered from various deficiencies such as ill trained teachers, inadequate facilities and lack of support on the part of the parents. These unfavorable conditions has often resulted in lower level of achievement. For example, a comprehensive national survey conducted in the years 1974 has shown that in several areas of sciences and mathematics the achievement of Arab pupils in the elementary schools was substantially lower than that of their Jewish counterparts (Bashi, Kahn, Davis, 1981). Similarly, only 35% of the Arab students who sat for the matriculation examinations in the year 1973 have passed, compared with 50% passing of the Jewish candidates. This situation appears to be changing. In recent years the number of Arab academics has grown substantially and consequently more qualified teachers have been recruited by high schools. The success rate of Arab candidates in the matriculation examinations has been steadily going up. For example, in the year 1983 most Arab candidates who took the higher level mathematics matriculation examinations (4 or 5 points) have passed. The success rate of

Arab students who took the 3 points mathematics matriculation examination in 1983 was 62%, compared with only 56% of the Jewish candidates (Saad, 1984, p. 79).

Biology has become a very popular elective matriculation subject. The number of candidates, both Jews and Arabs, has been steadily increasing. So far no attempt has been made to compare the achievement of Jewish and Arab students in high school biology. Even the current evaluation of science in Israel as part of the Second International Sciences Study conducted within the framework of the International Association for the Evaluation of Educational Achievement (IEA) excludes Arab students. The only published comparison between Arab and Jewish high school students related to biology indicates that in spite of substantial cultural and home differences as far as cognitive preferences in biology are concerned similar patterns exist among Jewish and Arab students. The study of inquiry oriented biology curriculum for several years results for both nations in becoming more oriented toward fundamental principles and critical questioning and less toward rote memorization (Tamir, 1983). How about achievement?

Purpose of Study

The objectives of this study are to:

1. Compare the biology achievement of Jewish and Arab students in higher and lower level paper and pencil matriculation examinations.

2. Compare the performance of Jewish and Arab students in higher and lower level practical laboratory matriculation examinations.
3. Compare the achievement of boys and girls in the examinations mentioned above.
4. Explain differences and similarities which will be identified.

Since the study is based on the results of the matriculation examinations in biology, a brief description of these examinations follows.

The Biology Matriculation Examination

Because of the inquiry orientation of the high school biology program, the matriculation examinations in all levels, in an attempt to reflect the major diverse objectives, consist of a variety of tests exhibiting diversity of tasks as well as test formats. Like in other subjects we have higher as well as lower level examinations.

In biology: the higher level assumes participation in biology classes for 15 weekly hours spread over grades 10, 11, 12 and requires broad knowledge of the major topics of biology, more sophisticated in-depth command of selected topics and the ability to apply inquiry skills to solve novel problems and explain novel situations both in paper and pencil and in practical laboratory tests; the lower level assumes participation in biology classes for 6 to 9 weekly hours over 3 years (or the equivalent in two

years) and requires general knowledge of selected topics (core and electives) and less sophisticated problem solving in inquiry skills both in the paper and pencil and in the practical laboratory test. All the students are expected to study biology for 3 weekly hours in the 9th grade.

The higher level paper and pencil test consists of three parts:

Part A is comprised of 35 multiple choice items covering human biology, botany, zoology, genetics, microbiology and general biology.

Part B is comprised of six problem situations which require the student to describe the presented phenomena and explain what was happening and why it happened.

Part C presents an unseen research report and requires critical analysis as well as planning the next step in that research study. Three hours are allocated for the test. The higher level practical test lasts two and a half hours and requires students to solve a novel problem by exercising hypothesis formulation, experimental design, data collection, interpretation and communication of results and conclusions.

In addition to the above, candidates are examined orally. The oral test is based on an ecological project performed individually by each candidate during the last two years of studying high school.

The lower level paper and pencil test which lasts two hours is comprised of 20 multiple choice items (14 covering core curriculum, 6 covering electives) and short essay answers to questions related to two simple excerpts from scientific articles published in local science magazines. The lower level practical test which lasts for an hour and a half is comprised of four tasks: identifying an unknown plant with the aid of a key, observation with a microscope and two simple experiments. The examinations are scored by examiners appointed by the Ministry of Education.

Further details and results of several previous examinations have been reported in the professional literature (e.g. Jungwirth and Dreyfus, 1972; Tamir, 1974; Tamir, Nussinovitz and friedler, 1982; Tamir, 1985).

Method

An attempt was made to collect data based on all the results of the biology matriculation examinations in the years 1983, 1984 (excluding the results of the oral examinations). Although the Ministry of Education makes efforts to analyze the test results and provide feedback to the schools, so far, due to technical reasons, only a limited amount of information is available from that source, mainly total scores for individual students and for individual schools. Some of the results reported here are based on this information. However, most results, especially those pertaining to subtests and to detailed item analyses of multiple choice items and of the practical laboratory tests, are based on

data collected through special arrangements made by the author and the high school biology team in the Israel Science Teaching Center who supervised the assessment of the tests in the National Assessment Center operated by the Examination Department of the Ministry of Education. The data was analyzed at the Hebrew University using special test scoring and SPSS programs yielding means, standard deviations and t tests. Due to technical reasons some information was not available for comparative analysis. Hence, the following parts of the matriculation examinations were analyzed in this study:

	1983	1984
5 points paper and pencil test		
Part A	+	+*
Part B	+	-
Part C	+	-
5 points practical laboratory test	+	+
2 points paper and pencil test		
Part A	+	+*
Part B	-	-
2 points practical laboratory test	-	+

* This included also analysis by the cognitive level of the items

Results

The 5 points examination

The results of the 5 points examination are presented in Tables I, II, III and IV.

Insert Tables I, II, III, IV about here

It may be seen that close to 30% of the candidates who took this examination were Arabs. The percentage of girls among the examinees was 77% and 44% for Jews and Arabs respectively.

Following are the major findings:

1. In both years the performance of Jewish students was significantly and substantially higher than that of Arab students in all the parts of the paper and pencil test. However, a closer examination reveals that the differences in Part A are smaller in 1984 than in 1983. It may also be observed that the difference in performance related to items at the knowledge level is smaller than in items which require comprehension and higher cognitive abilities.
2. In the year 1983 there were statistically significant differences in favor of Jewish students in all the skills assessed by the inquiry oriented practical test. Such differences did not occur in the year 1984 regarding the following skills:

   performing observations

   making drawings of observations under the microscope

   formulating a problem

   formulating an hypothesis

   identifying the dependent variable

   changing the independent variable

   explaining results

   Thus it appears that in these areas the gap between Jewish and Arab students is closing.

3. The main deficiencies of Arab students in the practical mode remain in performance involving quantitative procedures, in reporting, and in certain skills of analysis and interpretation.

4. The difference between Jewish and Arab students in performance in the paper and pencil test are substantially larger than those obtained in the practical inquiry oriented test. This is especially true for inquiry skills which are measured by Part C of the paper and pencil test as well as by the practical test.

5. Since the differences between Jewish and Arab students in part A of the paper and pencil test are substantially greater than in Part B of the same test, it may be suspected that Arab students have, on the average, more difficulty in handling multiple choice items, or that their broad knowledge of a variety of areas in biology as represented in Part A, is indeed deficient while in topics which they study in depth and in which they invest more time they achieve better.

6. Boys and girls achieved equally well. There were only two statistically significant differences between Jewish boys and girls and only one statistically significant difference between Arab boys and girls, all in Part A (See Table VII). There were no statistically significant gender differences

either in Parts B and C of the paper and pencil tests or in the practical tests, neither for Jewish nor for Arab students.

The 2 points examination

The results of the 2 points examinations are presented in Tables V and VI.

Insert Tables V and VI about here

It may be seen that about 25% of the candidates who took this examination were Arabs. The percentage of girls among the examinees was 79% and 46% for Jews and Arabs respectively. Following are the major findings:

1. Jewish students outscored Arab students in all areas of the paper and pencil test in 1983 but not so in 1984. The general performance of the Arabs has improved substantially in 1984 and reached parity with that of Jews in human biology, botany and zoology.

   The gap between Jewish and Arab students appears to have closed in items which require knowledge but Jews were still better in items which required comprehension and higher cognitive abilities.

2. Jewish students outscored Arab students in the following parts of the practical: plant identification, preparing a slide and observing it under the microscope and identifying control. However, Arab students achieved better than Jewish

students in calculating the magnifying power of a microscope, in reporting a simple observation, in interpreting, in analyzing, in explaining and in drawing conclusions.

3. There were no statistically significant gender differences for Jewish students either in the paper and pencil or in the practical test. Similarly there were no gender differences for Arabs in the practical test. On the other hand, however, Arab boys achieved better than girls in Part A of the paper and pencil test especially in botany and in genetics (See Table VII).

Discussion

The major finding of this study is that while significant differences still exist between Jewish and Arab students in favor of the former, the gap appears to be closing, especially in tasks which require either lower cognitive abilities or the application of inquiry skills to solve simple problems in the laboratory. When higher cognitive skills and more abstract reasoning are involved, the performance of Arab students is, on the average, substantially lower than that of comparable Jewish students. What are the reasons for the differences? We can only speculate here. The presently taught inquiry oriented biology curriculum was introduced to Israeli high schools in 1965 and has been gradually and voluntarily adopted by teachers. Arab teachers were among the last to adopt this program probably because of its major departure from traditional lecture-demonstration approach

and its heavy orientation towards inquiry. In fact the number of Arab candidates has doubled between the years 1980 and 1983.

Only more recently as young and better educated teachers have taken over this inquiry approach has been widely implemented in Arab classrooms. It is not easy for students to acquire such a revolutionary approach to learning especially when the old tradition still dominates in the study of other school subjects. Based on this analysis we believe that the present inferiority of Arab students in higher level performance is only temporary. The fact that Arab students have already reached the level of their Jewish counterparts in certain areas may be a sign that in due time they will reach the same level in higher level tasks, especially if their biology teachers will work with them in this direction. Further support for this prediction is lended by the already mentioned high rate of success of Arab students in the mathematics matriculation in the last two years.

An important and somewhat unexpected finding is the difference in boys: girls ratio between the Jewish and the Arab populations: there were more than 3/4 Jewish girls as compared with less than 50% Arab girls. The reason for this may be the fact that 55% of the Jewish students enroll in vocational high schools compared with less than 20% of the Arab students. Since the majority of students in vocational schools are boys, it is not surprising that over 70% of the students in Jewish academic high schools which provide the candidates for the biology matricula-

tion are girls. On the other hand the boys: girls ratio in Arab academic schools is very similar to that found among the Arab candidates for the biology matriculation examination. Thus the different boys: girls ratios reflect a structural difference between the two educational systems rather than a personal or cultural difference.

Another important finding of this study is that by and large both Jewish and Arab girls achieve in biology as well as boys. The only main exception, namely the lower achievement of girls in Part A of the 20 points paper and pencil test may indicate that the girls in that population require special attention. While it is true that the literature reports substantially lower achievement of girls in the physical sciences than in biology, it is still generally expected that boys outscore girls in biology especially in tasks which require formal reasoning and higher intellectual skills (e.g. Comber and Keeves, 1973; Sansanwal 1983; Marsh and Anderson 1985). It is satisfying to find out that this is not the case in Israel and that our currently taught inquiry oriented biology suits equally boys and girls and appeals to both genders in the two nations.

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Table I

Achievement of Jewish and Arab Students in the Paper and Pencil 5 Points Matriculation Examination in the Year 1983

Part	No. of Items	Topic	Jewish N=2808 $\bar{x}$[a)]	S.D.	Arab N=965 $\bar{x}$[a)]	S.D.	t
A	35	Total	71	13	59	14	18.85***
	3	Human Biology	68	28	64	30	3.27**
	11	Botany	77	16	64	16	16.23***
	9	Zoology	67	18	52	20	17.30***
	6	Genetics	73	22	61	22	12.04***
	6	General Biology	63	20	52	22	10.83***
B[b)]	45	Total	70	14	67	13	5.84***
	15	Blood Circle Regulation	73	17	66	18	10.86***
	15	Population Growth	68	16	63	15	8.50***
	15	Hereditary Patterns	75	23	66	23	10.47***
	15	Energy Transformation	62	19	55	15	10.37***
	15	Microbiology[c)]	73	18	70	15	4.66***
	15	Reproduction[c)]	65	21	62	19	3.92***
C	25	Total	66	16	51	17	24.69***
	3	Drawing conclusions	77	21	61	21	20.39***
	3	Drawing conclusions	66	22	52	22	17.03***
	3	Drawing conclusions	65	24	49	23	18.03***
	3	Identifying role of control	57	26	43	23	14.83***
	2	Employing statistical tests	50	40	45	36	3.43***
	3	Formulating research problems	56	30	49	29	6.30***
	8	Designing experiments	59	21	42	23	21.14***

a) Raw scores were transformed to percentage scores
b) In Part B students choose 3 out of 6 questions, hence the N for each question ranged from 411 to 2317 for Jewish and from 59 to 893 for Arab students.
c) Essay questions

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table II

Achievement of Jewish and Arab Students in Part A of the Paper and Pencil 5 points Matriculation Examination in the Year 1984

No. of Items	Topic	Jewish N=2425 $\bar{x}$[a)]	Jewish N=2425 S.D.	Arab N=1006 $\bar{x}$[a)]	Arab N=1006 S.D.	t
35	Total	68	13	63	15	16.38***
9	Human Biology	63	16	54	21	12.62***
3	Botany Morphology	57	29	55	31	2.29*
8	Botany Physiology	63	22	54	22	11.77***
6	Zoology	76	18	69	21	9.25***
4	Genetics	74	23	57	24	19.40***
3	General Biology	79	24	76	25	3.37**
2	Statistics	72	34	61	36	8.60***
15	Knowledge	65	14	58	18	10.10***
10	Comprehension	74	18	63	19	15.33***
10	Higher Cognitive Levels	66	17	56	17	15.93***

a) Raw scores were transformed to percentage scores

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table III

Achievement of Jewish and Arab Students in Different Inquiry Skills in the Practical 5 Points Matriculation Examination in the Year 1983

Process Skill	No. of Items	Highest Possible Score	Jewish N=786 N	$\bar{X}$	S.D.	Arab N=295 N	$\bar{X}$	S.D.	t
PERFORMANCE									
Performing observations	3	4	1013	3.56	.79	290	3.16	1.13	6.85**
Performing measurements	4	2	710	1.73	.46	225	1.56	.50	4.73**
PLANNING									
Identifying a problem	1	6	221	4.53	1.66	80	3.83	1.56	3.32**
Identifying dependent variable	2	5	392	4.51	.85	111	4.14	1.15	3.72**
Identifying independent variable	1	4	218	3.51	.91	80	3.23	1.08	2.30*
Changing independent variable	1	3	218	2.77	.53	80	2.59	.65	2.26*
Fitting experiment to hypothesis	2	3	420	2.68	.56	139	2.46	.65	3.85**
REPORTING									
Tables	2	4	420	3.56	.74	137	3.22	.97	4.31**
Making a graph	1	2	197	1.85	.37	50	1.70	.46	2.09*
ANALYSIS AND INTERPRETATION									
Drawing conclusions	2	3	486	2.83	.46	166	2.65	.62	3.96**
Interpreting	1	4	381	3.45	.86	104	3.25	.88	2.09*
Explaining	2	4	560	3.61	.63	158	3.35	.77	4.35**
Applying prior knowledge	3	5	680	4.32	1.08	224	3.92	1.33	4.53**

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table IV

Performance of Jewish and Arab Students in Different Inquiry Skills in the Practical 5 Points Matriculation Examination in the Year 1984

	Jewish			Arab			
Inquiry Skills	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	t
PERFORMANCE							
Performing observations	2000	91.3	14.9	700	90.0	15.4	1.85
Performing measurements	2427	88.6	20.9	843	84.1	22.9	5.05***
Preparing dilutions	932	85.8	26.9	361	81.2	28.7	2.62**
Making calculations	1601	86.0	25.3	599	82.6	23.0	3.01**
PLANNING							
Formulating a problem	763	71.6	33.6	263	71.0	28.0	.26
Formulating an hypothesis	2500	80.8	27.3	840	81.1	26.6	.23
Identifying dependent variable	2669	81.7	27.6	938	82.4	26.2	.72
Measuring dependent variable	2669	79.4	30.3	938	76.8	30.5	2.22*
Identifying independent variable	1895	81.3	30.3	629	78.3	29.6	2.15*
Changing independent variable	669	87.4	24.6	238	85.9	24.6	.79
Fitting experimental design to hypothesis	2669	73.3	27.7	938	67.7	27.0	5.58***
REPORTING							
Preparing tables	1610	86.1	18.7	569	80.3	19.0	6.34***
Making graphs	1432	76.7	25.4	501	72.8	24.2	3.09**
Making drawings	463	87.6	21.4	128	84.4	23.1	1.41
Determining method of reporting	605	88.3	26.1	211	75.1	33.8	5.15***
ANALYSIS AND INTERPRETATION							
Interpreting results	1132	77.4	29.1	366	83.6	23.3	4.31***
Explaining results	1610	76.5	26.0	569	76.3	23.8	.22
Summarizing results	1068	78.3	24.0	339	71.6	24.6	4.42***
Drawing conclusions	1906	85.4	18.2	675	80.1	19.6	6.06***
Determining limitations	932	69.7	36.5	361	64.2	34.1	2.56*
Applying prior knowledge	2669	78.8	20.7	938	76.5	21.1	2.90*
TOTAL SCORE	2669	82.0	10.7	938	78.9	10.6	7.54***

*p<0.05 ** p<0.01 *** p<0.001

Table V

Achievement of Jewish and Arab Students in Part A of the Paper and Pencil 2 Points Matriculation Examination

Year	No. of Items	Topic	JEWISH $\bar{x}$[a)]	JEWISH S.D.	ARAB $\bar{x}$[a)]	ARAB S.D.	t
1983	26	Total	71	16	62	16	11.03***
	8	Human Biology	69	28	62	30	5.05***
	3	Botany	79	25	74	27	3.73***
	6	Zoology	67	20	52	21	14.39***
	2	Genetics	56	37	53	36	1.62
	7	General Biology	73	21	64	25	7.50***
1984	26	Total	72	16	69	17	4.01***
	6	Human Biology	68	31	66	31	1.47
	5	Botany	66	23	68	22	1.56
	6	Zoology	74	27	75	26	.82
	3	Genetics	75	32	66	36	4.91***
	6	General Biology	74	27	68	30	4.00***
	13	Knowledge	72	17	72	18	.55
	9	Comprehension	72	21	65	24	6.15***
	4	Higher Cognitive Levels	72	16	69	16	4.50***

a) Raw scores were transformed into percentage scores

*** $p<0.001$

Table VI

Achievement of Jewish and Arab Students in the Practical 2 Points Matriculation Examination in the Year 1984

Process Skill	No. of Items	Highest Possible Score	Jewish N=786 $\bar{X}$	Jewish N=786 S.D.	Arab N=295 $\bar{X}$	Arab N=295 S.D.	t
Making a preparate for observation under the microscope	1	8	6.87	1.94	6.33	2.56	3.28**
Drawing under the microscope	1	6	4.33	1.74	3.40	2.17	6.53***
Identifying structures under the microscope	1	6	4.20	2.00	3.85	2.28	2.30*
Calculating magnification	1	5	4.26	1.27	4.51	.86	-3.69***
Making observations	3	2	1.85	.41	1.95	.26	-3.90***
Explaining experimental design	2	5	2.74	1.66	3.08	1.30	-3.17**
Interpreting	1	5	2.91	2.11	3.51	1.70	-4.88***
Drawing conclusions	1	3	1.79	1.23	1.98	.99	-2.56*
Identifying control	1	6	4.58	1.79	4.08	1.57	4.45***
Applying prior knowledge	1	5	3.41	1.69	3.92	1.22	-5.41***

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table VII

STATISTICALLY SIGNIFICANT DIFFERENCES IN ACHIEVEMENT OF BOYS AND GIRLS IN PART A OF THE PAPER AND PENCIL MATRICULATION EXAMINATIONS IN 1984

Test	Nation	Area	$\bar{x}^{a)}$	S.D.	$\bar{x}^{a)}$	S.D.	t
5 points	Jewish	Botany physiology	66	22	62	21	3.49***
		Higher cognitive levels	68	18	66	17	2.66**
	Arab	Statistics	63	36	57	37	2.02*
2 points	Arab	Genetics	80	29	61	35	3.87***
		Botany	71	20	63	22	2.67**
		Knowledge	77	16	70	16	3.11**
		Higher cognitive levels	78	22	62	29	3.81***
		Total	76	14	67	15	3.81***

a) Raw scores were transformed into percentage scores

* $p<0.05$ ** $p<0.01$ *** $p<0.001$